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Analyzing the fast-start performance of northern pike using a mechanical fish YAHYA MODARRES-SADEGHI, CHENGCHENG FENG, BRIAN BONAFILIA, ANDREW COSTAIN, UMass Amherst — The northern pike is able to achieve an instantaneous acceleration of 245 m/s^2 through a two-stage motion. In the first stage the fish curls its body into either a C-shaped or an S-shaped curve (preparatory stage), and in the second stage uncurls it very quickly (propulsive stage) generating high accelerations due to the vortices shed from its tail. We have built a mechanical fish, based on the body profile of a pike, which is capable of performing this two-stage fast-start motion. Movement is governed by servo motors, which pull on cables attached to certain ribs, bending the fish into a C- or an S-shape. The degree of bending and timing of strokes can be controlled, and the fish can perform either a propulsive stroke only or a full stroke consisting of both the preparatory stage and the propulsive stage. The mechanical fish is capable of achieving peak accelerations of around 4 m/s^2 . We use this fish in order to study the influence of various variables on the observed acceleration. Although the maximum accelerations observed in our mechanical fish are smaller than those of a live fish, the form of the measured acceleration signal as function of time is quite similar to that of a live fish. The hydrodynamic efficiencies are observed to be around 12%, and it is shown that the majority of the thrust is produced at the rear part of the mechanical fish – similarly to the live fish.

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